then will the lines VA and VD coincide in every point, for they are equal by the construction; and in like manner, let the plane BEC be conceived to be turned about the line BC, until BE coincides with BA, and CE with CD; then will the plane BEC be perpendicular to each of the two planes AVB and DVC, for two sides of it, namely, BE and CE, or their equals, BA and CD, are perpendicular to the same point of the line of common section, AV and DV becoming one line on the elevation of the planes, and the points A and D coinciding.

In a similar manner the inclination of the planes BVC and DVC may be determined; but as that inclination does not enter the solution of the original problem, it is not necessary to consider it. We shall therefore now proceed to investigate the rules for calculating the angles BEC and DVC, the same rules being general for the several courses in the arch.

Put $a$ = the angle CVD at the vertex of the hypothenusal plane;

Put $b$ = the angle BVC at the vertex of one of the perpendicular planes;

Put $c$ = the angle AVB at the vertex of the other perpendicular plane; and,

Put $\phi$ = the angle BEC, the inclination of the two planes AVB and CVD.

Here, then, it is manifest, that if the straight line VB be assumed as radius, BC will be the tangent of the angle BVC to that radius, and VC the secant of the same angle; while AB = BE is the sine and AV = VD the cosine of the angle AVB; therefore, by expressing these quantities in terms of our notation, we get BC = tan. $b$; VC = sec. $b$; AB = BE = sin. $c$; and AV = VD = cos. $c$; hence, in the right-angled triangle BEC, we have given the two sides BC and BE, to find the angle BEC; wherefore, by plane trigonometry, it is

BE : BC :: rad. : tan. BEC; that is,

$$\text{sin. } c : \text{tan. } b :: \text{rad.} : \text{tan. } \phi = \frac{\text{rad.} \times \text{tan. } b}{\text{sin. } c},$$

from which, by assuming the radius equal to unity, and substituting the term cosec. $c$ as a multiplier, instead of sin. $c$ as a divisor, we get the following equation, viz.:—

$$\text{tan. } \phi = \text{tan. } b \text{ cosec. } c. \qquad (A)$$

Now, this expression is common for the angle of inclination between the planes AVB and CVD, and it means, that the tangent of the angle of inclination between the hypothenusal plane and one of the perpendicular planes, is equal to the cosecant of that plane, multiplied by the tangent of the other perpendicular plane.

We have next to determine the angle CVD at the vertex of the hypothenusal plane, and for this purpose we have given the sides VC and VD in the right-angled triangle CVD: hence, by plane trigonometry, it is

VC : VD :: rad. : cos. CVD; that is,

$$\text{sec. } b : \text{cos. } c :: \text{rad.} : \text{cos. } a = \frac{\text{rad.} \times \text{cos. } c}{\text{sec. } b},$$

from which, by assuming the radius equal to unity, and substituting cos. $b$ as a multiplier for sec. $b$ as a divisor, we get the following equation, viz:—

$$\text{cos. } a = \text{cos. } b \text{ cos. } c. \qquad (B)$$

The meaning of this equation is, that the cosine of the angle at the vertex of the hypothenusal plane, is equal to the product of the cosines of both the angles at the vertices of the perpendicular planes.

Having thus shown the method of construction, and determined (A and B) the formulæ of calculation, we must now proceed to show how they are to be applied in determining the bevels of the quoins in an oblique semicircular arch.

EXAMPLE.—Required the bevels of the quoins, and the form of the coursing joints, in an oblique semicircular arch of 25 equal courses, the span being 38 feet, and the obliquity 45°.

In resolving this question, it will materially assist the conception to consider the bed of each course as a parallelogram, one side of which is the line of joint down the face of the arch, and the other the corresponding line along the soffit; and the object to be determined, is the inclination of these two lines, which for one half of the arch will be obtuse, and for the other half it will be acute, the opposite halves reversing the inclinations.

By the question, there are to be 25 equal courses in the arch: this gives twelve courses on each side of the crown course; but in resolving the problem, it is only necessary to determine the moulds for twelve courses, as the same moulds can also be accommodated to the other twelve on the opposite side of the crown course. In order, however, to avoid confusion in the figure, we shall only show the construction of the moulds for one course; and this we shall take at the sixth course or division from the abutment, which will embrace 43° 12′ of the arch, each course occupying a space of 7° 12′: hence the following construction.

Let BV (Fig. 2) be equal to 19 feet, or half the span of the arch according to the question; and at the centre V, make the angle BVC equal to 45°, the given obliquity; then is VC the central line of the plan, and in the direction of the abutments: make also the angle BVF equal to 43° 12′, the portion of the arch for which the construction is intended. In VC take any point C, no matter where, and from C demit the perpendicular CB upon VB, thereby determining the position of the point B. From B as thus found, let fall the perpendicular BA; make BE equal to BA and draw CE; then is the angle BEC, or its supplement CEV, the inclination between the face of the arch and its plan, according to the part of the arch for which the construction is made.

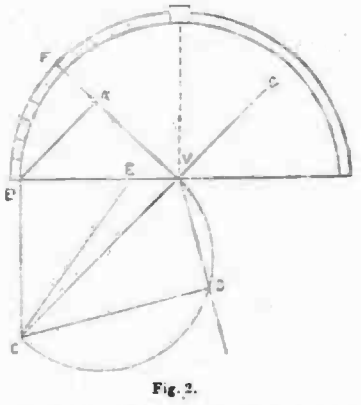


Fig. 2.

Upon CV as a diameter describe the semicircle CDV, in which inflect the chord VD equal to VA; then is the angle CVD, or its supplement DVG, the inclination between the joint line in the face of the arch, and the corresponding joint line along the soffit.

It will here be seen that the figure VABCD in the second diagram as referred to the arch, is precisely the same as the expanded pyramid in the first figure, only here the vertex of the pyramid is at the central point of the span.

From what we have done above, it is manifest that the same mode of construction will apply to any point of the arch, whatever may be the number of the course; but it must be borne in mind, that each course in the semi-arch will require its own moulds, which moulds will also answer for the corresponding courses in the other semi-arch. It now remains to show how to apply the formulæ (A and B) in calculating the angles of bevel; and first, for the bevel between the face of the quoin and the coursing joint or bed of the succeeding course; this requires the application of formula A, and the rule, logarithmically expressed, is as follows:—

RULE.—*To the logarithmic tangent of the constant obliquity, add the logarithmic cosecant of that portion of the arch for which the angle of bevel is wanted, and the sum, less ten in the index, will be the logarithmic tangent of the required angle.*

The process of calculation for the sixth course from the abutment is as under:—

| | |
|---|---|
| Given obliquity of the plan, 45° 0′ . . | log. tan. 10·000000 |
| Given portion of the arch, 43° 12′ . | log. cosec. 10·164597 |
| Required angle of bevel, 55° 36′, or 124° 24′ | log. tan. 10·164597 |

Here the angle has two values, and the one or the other must be used according to the semi-arch in which the course occurs.

Next, to find the inclination between the line of joint in the face of the arch, and the corresponding joint along the soffit; this requires the application of formula B, and the rule, expressed logarithmically, is as follows:—

RULE.—*Add together the logarithmic cosines of the constant obliquity, and that portion of the arch for which the inclination is required, and the sum, less ten in the index, will be the logarithmic cosine of the required inclination.*

According to this rule, the operation is as follows:—

| | |
|---|---|
| Given obliquity of plan, 45° 0′ . . . . . | log. cos. 9·849485 |
| Given portion of the arch, 43° 12′ . . . . . | log. cos. 9·862709 |
| Required angle of inclination, 56° 58′, or 121° 2′ | log. cos. 9·712194 |

Here, as in the case above, the inclination is of two values, answering to the two semi-arches, the obtuse value answering to one semi-arch, and the acute value to the other. And exactly in the same manner may all the other angles of bevel be calculated for every point of the arch.

T.

## IRISH BUILDING MEMS.

A NEW Roman Catholic church, with school attached, is to be erected in each of the districts of Glan and Derry. The expenses will be defrayed by subscription.

Alterations and additions are to be made to Drogheda prison, according to plans prepared by Mr. John Neville, Dundalk, architect, by whom tenders are being received.

The first stone of St. Catherine's new Roman Catholic church, at Meath-street, Dublin, has been laid by the R. C. Archbishop, Dr. Cullen.

The board of directors of the Clonmel Mechanics' Institute are about erecting additions to the present buildings. On the ground-floor will be an entrance-hall, 10 feet wide, with a reading-room and library to the left, and a museum to the right; and overhead an exhibition-room, 47 feet 6 inches, is provided, in connection with the present lecture-hall, which is 64 feet by 21 feet 6 inches. The style of the new buildings will be Grecian.

A new campanile of large dimensions is to be erected in connection with Trinity College, Dublin, and designs have been furnished for same by Mr. Charles Lanyon, of Belfast, architect.

A new Roman Catholic church is to be erected at Kilmoree, by subscription, and the designs, which we believe are in the Gothic style, are by Mr. John S. Butler, architect.

At Thurles a new schoolhouse is to be built.

Mr. Dargan's offered advance of 20,000*l.* for the purpose of erecting a building on the premises of the Royal Dublin Society, Merrion-square, for holding an extensive exhibition of the products of the United Kingdom in the year 1853 (if the scheme be carried out satisfactorily), will, no doubt, be a stimulus for the permanent establishment of periodical exhibitions on a much more important and extensive scale than hitherto attempted. And in the selection of plans for the proposed building (which, we understand, are to be competed for) we hope that the committee will display more business-like disposition than they manifested on a recent occasion when the plans of competitors were detained for upwards of twelve months while deliberating on the award of a small "premium" of 10*l.* It is to be hoped that no local influence will interfere with a fair spirit of competition. Upwards of 100,000 superficial feet are to be provided, and the cost of erection is not to exceed 15,000*l.*

The first stone of the new Church of Knappagh, near Westport, has been laid by the bishop, and the ceremony was witnessed by upwards of 600 spectators.

A new terminus, goods store, and engine shed are to be erected in connection with the Killarney Junction Railway at Killarney according to plans furnished by Mr. Joshua Hargrave, jun. architect.

The electric telegraph is now at work on

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